

### Threaded Ring

The invention relates to a threaded ring the one-piece body of which provided with internal threading has at least two body components, the first of which is in the form of a set collar with an end plane surface in a radial plane, and the second body component of which forms a retaining ring which is connected to the first body component to form a gap positioned between the two body components by way of an elastically flexible wall component of the body and has an actuating mechanism by means of which the geometry of the gap can be adjusted on the basis of the elastic flexibility of the wall component along the longitudinal axis of the body.

Threaded rings of this type, which have been disclosed in DE Patent Application 1 675 685, for example, are commercially available and are applied in various areas of mechanical engineering. The body component forming the plane surface serves as a high-precision nut seated on the external threading of a shaft or spindle, a nut the axial position of which along the longitudinal axis of the threaded ring can be determined with high accuracy by means of the second body component which is used as the retaining ring, the threaded flank clearance present between external threading and internal threading being eliminated in that the width of the gap between the two body components is modified accordingly by the actuating mechanism, such modification being made possible by the elastic flexibility of the wall component which forms the body components.

The actuating mechanism can be set screws which permit reciprocal tightening of the set collar and the retaining ring. The set collar may function as an adjusting nut with a plane surface which forms a contact surface for positioning of roller bearings on shafts or can be used as a precisely positioned shaft collar or the like.

In the instances of the disclosed threaded ring described in the foregoing, the gap between the body components is formed by two gap segments offset from each other in the axial direction, one of which extends from the threaded bore to the vicinity of the circumference of the threaded ring, and the other radially inward from the circumferential surface to the vicinity of the threaded bore. Between the two gap segments there is an elastically flexible wall component which connects the two body components and which has a wall thickness which is selected in such a way that this wall component is elastically flexible such that the geometry of the gap may be adjusted by the set screws serving as actuating mechanism so that the threaded flank clearance is eliminated and the locking effect desired is achieved by tensioning the two body components. The relatively high production cost is a disadvantage of the disclosed threaded ring.

EP 0 956 768 A1 discloses another generic threaded ring which is made as a precision tensioning nut. The disclosed precision tensioning nut has a solid nut block having an internal threading, an end face which has been machined flat and which is aligned at a right angle to the axis of the thread, and a circumferential surface. Individual clamping elements each form a radially extending segmented sector from a part of the nut block. The clamping elements in the disclosed solution for the purpose of axial locking by means of a clamping screw which may be operated parallel with the axis may be elastically inclined. The clamping elements moreover form at most 50% of the indicated component such that in axial locking on the tensioning side at most 50% of the circumference of the thread in the form originally produced are changed. Distortion of the plane surface and loosening by insufficient locking are thus avoided. This disclosed solution compared to the initially mentioned solution in the prior art has only one open gap segment and not two, which

gap segment is moreover also closed to the outside so that no foreign substances are able to penetrate from the outside into the gap area and the production effort and the costs are thus reduced accordingly; only the production of the segmented clamping element is in turn associated with increased production effort, and achieving a uniform application of the clamping force is likewise made difficult as a result of the segmented configuration of the clamping elements.

DE-A-102 52 780 A1 discloses another generic threaded ring, the second body component used as the retaining ring to form the elastically flexible wall component having a circumferential area which compared to the first body component is reduced to an outside diameter which clearly is situated over a smaller radius than the end of the gap which is situated radially to the outside, and the circumferential area of the second body component which has been reduced in diameter ending at an axial distance from the gap which defines the extension of the flexible wall component in the axial direction.

Instead of the complex production of two gap sections, in this disclosed solution with the formation of the flexible wall component only the configuration of an integral gap as an internal recess and the external machining of the second body component are necessary in order to reduce its outside diameter in areas; this can be effected by simple machining.

Furthermore, in the disclosed solutions there may be instances where after fixing the set collar on the assignable threaded piece and after subsequent tightening of the retaining ring plastic deformations may unintentionally occur along the threadings in question; this leads to the threaded ring becoming unusable and the threaded ring then possibly can no longer be removed from the clamping thread. Basically it is possible to prevent this problem by way of torque wrenches with a definable locking torque; in practical applications for the threaded ring, however, often in the absence of a suitable torque wrench, this measure is ignored and the threaded ring is fixed with conventional tools.

On the basis of this latter prior art, the object of the invention is to further improve the disclosed threaded ring solution while maintaining its advantages, specifically its being simple and economical to produce, so that at a reduced size high efficiency can still be achieved, i.e., that by tensioning the two body components the threaded flank clearance is effectively eliminated to achieve the desired locking action. This object is achieved by a threaded ring with the configuration of features claimed in claim 1.

In that, as specified in the characterizing part of claim 1, in the preinstallation state there is a contact surface between the components of the actuating mechanism and the components of the body which contact surface is provided with a definable inclination and because the angle of inclination relative to the longitudinal axis of the body is selected such that in the installed state the occurrence of threaded flank clearance is eliminated, in the installed state the clamping force of the actuating mechanism takes effect on the inside circumference near the threaded flanks which are to be clamped so that as a result of the favorable distances between the external radial end of the gap, the application of force of the actuating mechanism by way of the inclined contact surface and the threaded flanks to be clamped, high efficiency is achieved, that is to say, the threaded flank clearance is effectively eliminated to obtain an adequate locking effect. The threaded ring as claimed in the invention can be easily and economically produced and requires only little installation space since on the one hand there need not be two gap segments, but only one, and furthermore making the two body components different with respect to their circumferential area can also be omitted.

An additional advantage is that there is no gap segment open to the outside on the threaded ring; the threaded ring as claimed in the invention therefore has a closed circumferential contour so that this also avoids the danger that during operation foreign substances can settle in the gap area which otherwise is open on the circumference, for example contaminants, wear particles, shavings or the like, which are contained in the lubricants and which could lead to the formation of an

unbalancing mass on the circumference of the threaded ring. Based on the sleeve-like configuration moreover uniform application of force with the threaded ring is achieved, as is thus a high level of locking of the threaded ring at the installation site.

The claimed inclined positioning of the retaining ring before the defined fixing position of the threaded ring on the assignable thread moreover ensures that the set collar can be fixed in a defined manner and when the retaining ring is subsequently tightened, only the assignable threaded flank clearance is overcome before the application of the locking force by way of the retaining ring to the set collar takes place. As a result of this measure it has been found that in this way plastic deformations in the clamping process between the threads can for the most part be prevented so that even in an improper clamping process the threaded ring maintains its function and can also be easily removed again from the assigned thread.

In one preferred embodiment of the threaded ring as claimed in the invention provision is made such that the actuating mechanism has tensioning means which, to the extent they are countersunk into assignable recesses of the retaining ring in the installed state, form with their tightening contact surfaces to the front face of the retaining ring a clamping angle which corresponds to the angle of inclination in the preinstallation state. This yields the possibility of visual checking for a successfully completed clamping process using the indicated clamping angle.

Other advantageous embodiments are the subject matter of the other dependent claims.

The threaded ring as claimed in the invention is detailed below using two exemplary embodiments as shown in the drawings, in which in schematic form and not drawn to scale

- FIG. 1 shows a longitudinal section of only one-half side of the first exemplary embodiment of the threaded ring claimed in the invention on a threaded spindle, the diagram being

simplified for the sake of greater clarity of presentation of the principle of operation and in particular the threaded flank clearance being shown enlarged and the threaded ring being shown in the unlocked state, as it corresponds to the preinstallation state;

- FIG. 2 shows a representation which corresponds to FIG. 1, however the screw-on threaded ring being shown in the locked state, that is in the installed state; and
- FIGS. 3 and 4 show a second embodiment analogous to FIGS. 1 and 2.

The threaded ring shown in the figures has two primary components, specifically a first body component 10 which functions as a set collar or adjusting nut and a second body component 12 which forms a retaining ring. The two body components 10 and 12 are provided with continuous internal threading 14, 16 respectively, in the illustrated embodiment the internal threading 14 of the first body component 10 having more threads than the internal threading 16 of the second body component 12. With these internal threadings 14, 16 the threaded ring can be screwed onto a section of a spindle 20 which is provided with an external threading 18. Furthermore, the body component 10 has an end plane surface 22 which is used for fixing in position a ring body 24 which is seated on the spindle 20 as a shaft collar.

There is between the two body components 10 and 12 a gap 26 which in the installed state of the threaded ring extends in the radial direction from the external threading 18 and its radially external end 28 is spaced at a radial distance from the common circumference of the two body components 10, 12. The radially external end 28 of the gap 26 with the common circumference 30 borders a wall component 32 by way of which the first body component 10 and the second body component 12 are integrally joined to one another. The wall thickness of this wall component 32 is selected such that the wall component 32 forms a sort of weak point, that is to say, a flexible wall

component, which for a threaded ring which has been produced from a steel material, permits flexible adjustment of the position of the second body component 12 relative to the first body component 10, the corresponding adjustment of the geometry of the gap 26 being effected, the gap width being modified locally, for example.

As the actuating mechanism for adjusting the geometry of the gap 26 individual set screws 34 are used as tensioning means and penetrate the gap 26 parallel with the axis, fit into the threaded bores 36 of the first body component 10, and are supported with their screw heads 38 at the end on the second body component 12 in the installed state (compare FIG. 2). The set screws 34 are uniformly distributed over a graduated circle concentric with the longitudinal axis of the threaded ring, and six set screws (not shown) being provided, for example. In this exemplary embodiment the set screws 34 are configured as socket head cap screws with screw heads 38 which act on the free end face 40 of the threaded ring. Instead of the socket head cap screws which are shown, conventional hexagonal head screws can also be used cost-effectively, since in the illustrated embodiment as shown in FIGS. 1 and 2 the possibility exists of radially tightening the set screws 34 from the outside, not coming from the front face.

In the second embodiment as shown in FIGS. 3 and 4, conversely the screw heads 38 are held countersunk in the axially widening end segment of the pertinent through bore 42 such that in the preinstallation state the screw heads 38 are essentially flush with the external end face 44 of the second body component 12. The described widening end segment in the embodiment as shown in FIGS. 3 and 4 is also accompanied by a lengthened internal threading segment relative to the internal threading 16 of the second body component 12. Otherwise the two embodiments correspond to one another in terms of their function and action so that the details stated in the foregoing with respect to the first embodiment also apply accordingly to the subject matter of the second exemplary embodiment and for the second embodiment the same reference numbers are hence used for individual components as in the first embodiment as shown in FIGS. 1 and 2.

FIG. 1 shows the unlocked state, that is, the preinstallation state of the threaded ring, the existing threaded flank clearance of the thread engagement between the internal threadings 14 and 16, and external threadings 18 being shown enlarged for the sake of clarity. As is to be seen, here the flank surfaces of the internal threading 14, 16 which are situated on the right side in the drawing are situated at a distance from the flank surfaces of the external threading 18 which are situated on the left side in the drawing.

FIG. 2 shows the locked state, that is to say, the installation state, in which by actuating the actuating mechanism with the individual set screws 34 the second body component 12 is tensioned against the first body component 10 such that for the second body component 12 the flank surfaces of the internal threading 16 which are situated on the right side are supported on the flank surfaces of the external threading 18, conversely for the first body component 10 the flank surfaces of the internal threading 14 which are situated on the left side are supported on the external threading 18 so that the threaded ring unit formed from the body components 10 and 12, which are tightened against each other, is secured in its entirety.

The threaded ring as claimed in the invention is designed to be rotationally symmetrical and has no grooves, slots, etc. generating unbalance. The set screws 34 distributed uniformly over a concentric graduated circle in conjunction with the flexible configuration of the wall component 32 yield uniform clamping forces on the threading. These clamping forces ensure intensive contact of the threaded flanks of the internal and external threadings 14, 16 and 18 and accordingly high axial stiffness of the threaded ring over the entire circumference. Any form defect adjustments and surface compressions which may be present may be evened out during installation by increased tensioning of the body components 10 and 12. The plane surface 22 of the first body component 10 used as a set collar or adjusting nut may be aligned by deliberate uniform tensioning of the set screws 34 until complete balance is achieved. If necessary, individual set screws 34 may be

additionally tightened to compensate for tension on one side caused by the smallest errors of plane extension of the adjacent components.

In addition to the mutual positioning of gap 26 and the two body components 10, 12, the wall thickness of the elastically flexible wall component 32 is of importance in addition to the further significant configuration of the threaded ring as claimed in the invention, specifically in the preinstallation state between the components of the actuating mechanism in the form of set screws 34 and components of the body of the threaded ring, to provide a contact surface 46 which is provided with a definable inclination  $\alpha$ , the angle of inclination  $\alpha$  being selected relative to the longitudinal axis of the body such that in the installation state the threaded flank clearance which occurs is completely eliminated, as shown. The indicated angle of inclination  $\alpha$  for reliable use may assume values between one half to five degrees, but preferably it assumes values between one to three degrees, depending on the equalization to be achieved for the threaded flank clearance and the accompanying thread pitch.

The contact surface 46 extending at an incline in the preinstallation state which forms the head support surface for the screw heads 38 of the set screws 34 is always to be dimensioned such that the contact surface 46 for the respective screw head 38, after locking the screw connection is set at a right angle, at the earliest at the maximum possible threaded flank clearance of the screw connection (compare installation state as shown in FIG. 2). For the embodiments shown, most of the tensioning force generated by the set screws 34 acts near the external spindle thread 18 which is to be clamped so that the efficiency compared to the disclosed threaded ring designs is therefore significantly improved. Based on the improved efficiency during clamping and securing of the threaded ring on the spindle 20, the threaded ring as claimed in the invention can be deployed both in the axial and in the radial direction with very small dimensions. Furthermore, the improved efficiency also allows the new threaded ring to be designed with fewer set screws 34.

In the second embodiment as shown in FIGS. 3 and 4, there is in addition the distinctive feature that when the screw heads 38 are integrated into the through bores 42 in the installed state they form a clamping angle  $b$  relative to the external end face 44 of the retaining ring 12 which corresponds to the angle of inclination  $a$  in the preinstallation state and which allows visual monitoring of the type of locking in this way. If the respective hexagonal head screw with its screw head 38 is axially integrated in the assignable recess in the retaining ring 12, the use of socket head cap screws as shown in FIGS. 3 and 4 is recommended with the possibility of effecting clamping or loosening of the threaded ring by means of suitable tools from the axial longitudinal front side. In the embodiment as shown in FIGS. 1 and 2 conversely as the hexagonal head screw one is preferably used with a screw head 38 which has the hexagon on the outer circumferential side. In this way it is possible to effect the described clamping and loosening processes from the circumferential side of the threaded ring, that is to say, radially.